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THE PRESENT PROBLEMS OF GEOGRAPHY.

AN ADDRESS DELIVERED TO THE INTERNATIONAL CONGRESS OF
ARTS AND SCIENCES AT ST. LOUIS IN 1904.

BY

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The present problems of a science may, I hope, be viewed as those problems the solution of which at the present time is most urgent and appears most promising. Were present problems held to include the whole penumbra of our ignorance, I at least have neither the desire nor the competence to discourse upon them. So much has been written on the problems of geography in recent years that a detailed summary of the existing literature would be a ponderous work, and afford much dull and contradictory reading. I cannot even attempt to associate different views of the problems of geography with the names of their leading exponents, though, perhaps, if I were to do so, I should quote with almost entire approval the masterly address recently delivered to the American Association for the Advancement of Science by Prof. W. M. Davis.

Believing that every geographer should approach such a question as this by the avenue of his own experience, I offer a frankly personal opinion, the outcome of such study, research, and intercourse with kindred workers as have been possible to me during the last twenty years. The views I hold may not be representative of European, perhaps not even of British, geographical opinion, except in so far as they are the result of assimilating, more or less consciously, the writings and teachings of geographical leaders in all countries, retaining congenial factors, and modifying or reject-

ing those which were foreign to the workings of my own partially-instructed mind.

The history of every branch of science teaches that time works changes in the nature and the value of the problems of the hour. In successive ages the waves of existing knowledge make inroads upon the shores of ignorance at different points. For one generation they seem to have been setting, with all their force, against some one selected point; in the next they are encroaching elsewhere, the former problem left, it may be, partially solved; but gradually the area of the unknown is being reduced on every side, however irregularly.

In the beginning of geography the problem before all others was the figure of the Earth. Scientific progress, not in geography alone but in all science, depended on the discovery of the truth as to form. No sooner was the sphericity of the Earth established than two fresh problems sprang to the front, neither of them new, for both of them existed from the first—the fixing of position on the sphere and the size of the Earth. Geography, and science as a whole, progressed by the failures as well as by the successes of the pioneers who struggled for centuries with these problems. Latitude was a simple matter, theoretically no problem at all, but a direct deduction from the Earth's form, though its determination was practically delayed by difficulties of a mechanical kind. The problem of the longitude was far more serious, and it bulks largely in the history of science. Pending their solution, the estimates of size were rough guesses; had they been more accurate it is doubtful if Columbus could have persuaded any sane sailor to accompany him on his westward voyage to India, the coast of which he was not surprised to find so near to Spain as the Caribbean Sea.

After latitude could be fixed to a nicety, and longitude worked out in certain circumstances with nearly equal accuracy, the size of the Earth was determined within a small limit of error and the problem of geography shifted to detailed discovery. This phase lasted so long that even now it hardly excites surprise to see an article or to open a volume on the history of geography which turns out to be a narrative of the progress of discovery. Perhaps British geographers, more than others, were prone to this error, and for a time the country foremost in modern discovery ran some risk of falling to the rear in real geography.

It is not so paradoxical as it seems to say that the chief problem of geography at present is the definition of geography. Some learned men have said within living memory, and many have

thought, that geography is not a science at all, that it is without unity, without a central theory, that it is a mere agglomerate of scraps of miscellaneous information regarding matters which are dealt with scientifically by astronomers, geologists, botanists, anthropologists, and others. Geography is not so circumstanced. Although its true position has only recently been recovered from oblivion, it is a science, and one of long standing.

I have said before,* and I may repeat, because I can say it no better, that modern geography has developed by a recognizable continuity of change from century to century. I am inclined to give more weight than others have done to the remarkable treatise of Dr. Nathaniel Carpenter, of Exeter College, Oxford, published in 1625, as a stage in the growth of geographical thought and theory. The striking feature of Carpenter's book is the practical assertion of the claims of common sense in dealing with questions of superstition and tradition. Varenus, who died at the age of twenty-eight, published in 1650 a single small volume, which is a model of conciseness of expression and logical arrangement well worthy even now of literal translation into English. From several points in its arrangement I am inclined to believe that he was influenced by Carpenter's work. So highly was Varenus's book thought of at the time that Sir Isaac Newton brought out an annotated Latin edition at Cambridge in 1672. The opening definition as rendered in the English translation of 1733 (a work largely spoilt by stupid notes and interpolations) runs—

Geography is that part of *mixed mathematics* which explains the state of the Earth and of its parts, depending on quantity, viz., its figure, place, magnitude and motion with the celestial appearances, etc. By some it is taken in too limited a sense, for a bare description of the several countries; and by others too extensively, who along with such a description would have their political constitution.

Varenus produced a framework of Physical Geography capable of including new facts of discovery as they arose; and it is no wonder that his work, although but a part, ruled unchallenged as the standard text-book of pure geography for more than a century. He laid stress on the causes and effects of phenomena as well as the mere fact of their occurrence, and he clearly recognized the influence upon different distributions of the vertical relief of the land. He did not treat of human relations in geography, but, under protest, gave a scheme for discussing them as a concession to popular demands.

As Isaac Newton the mathematician had turned his attention

* British Assoc. Reports—Presidential Address in Section E. Glasgow, 1901.

to geography at Cambridge in the earlier part of the eighteenth century, so Immanuel Kant the philosopher lectured on the same subject at Königsberg in the later part. The science of geography he considered to be fundamentally physical, but physical geography formed the introduction and key to all other possible geographies, of which he enumerated five: *mathematical*, concerned with the form, size, and movements of the Earth and its place in the solar system; *moral*, taking account of the customs and characters of mankind according to their physical surroundings; *political*, concerning the divisions of the land into the territories of organized governments; *mercantile*, or, as we now call it, commercial geography; and *theological*, which took account of the distribution of religions. It is not so much the cleavage of geography into five branches, all springing from physical geography, like the fingers from a hand, which is worthy of remark, but rather the recognition of the interaction of the conditions of physical geography with all other geographical conditions. The scheme of geography thus acquired unity and flexibility such as it had not previously attained, but Kant's views have never received wide recognition. If his geographical lectures have been translated, no English or French edition has come under my notice; and such currency as they obtained in Germany was checked by the more concrete and brilliant work of Humboldt and the teleological system elaborated in overwhelming detail by Ritter.

Ritter's views were substantially those of Paley. The world, he found, fitted its inhabitants so well that it was obviously made for them down to the minutest detail. The theory was one peculiarly acceptable in the early decades of the nineteenth century, and it had the immensely important result of leading men to view the Earth as a great unit with all its parts co-ordinated to one end. It gave a philosophical, we may even say a theological, character to the study of geography.

Kant had also pointed to unity, but from another side—that of evolution. It was not until after Charles Darwin had fully restored the doctrine of evolution to modern thought that it was forced upon thinking men that the fitness of the Earth to its inhabitants might result, not from its being made for them, but from their having been shaped by it. The influence of the terrestrial environment upon the life of a people has been insisted upon too strongly by some writers—by Buckle, in his "History of Civilization," for example—but it is certain that this influence is a potent one. This relation between the forms of the solid crust of the

Earth and all the other phenomena of the surface constitutes the very essence of geography.

It is a fact that many branches of the study of the Earth's surface which were included in the cosmography of the sixteenth century, the Physiography of Linnæus, the Physical Geography of Humboldt, and perhaps even the "Erdkunde" of Ritter, have been elaborated by specialists into studies which, for their full comprehension, require the whole attention of the student; but it does not follow that these specializations fully occupy the place of geography, for that place is to co-ordinate and correlate all the special facts concerned so that they may throw light on the plan and the processes of the Earth and its inhabitants. This was clear to Carpenter in 1625, though it has been almost forgotten since.

The principles of geography on which its claims to status as a science rest are generally agreed upon by modern geographers, though with such variations as arise from differences of standpoint and of mental process. The evolutionary idea is unifying geography as it has unified biology, and the whole complicated subject may be presented as the result of continuous progressive change brought about and guided by the influence of external conditions. It is impossible to discuss the present problems of geography without once more recapitulating the permanent principles.

The science of geography is, of course, based on the mathematical properties of a rotating sphere; but there is force in Kant's classification, which subordinated mathematical to physical geography. The vertical relief of the Earth's crust shows us the grand and fundamental contrast between the oceanic hollow and the continental ridges; and the hydrosphere is so guided by gravitation as to fill the hollow and rise upon the slopes of the ridges to a height depending on its volume, thus introducing the great superficial separation into land and sea. The movements of the water of the ocean are guided in every particular by the relief of the sea-bed and the configuration of the coast-lines. Even the distribution of the atmosphere over the Earth's surface is affected by the relief of the crust, the direction and force of the winds being largely dominated by the form of the land over which they blow. The different physical constitution of land, water, and air, especially the great difference between the specific heat and conductivity or diathermancy of the three, causes changes in the distribution of the sun's heat, and as a result the simple climatic zones and rhythmic seasons of the mathematical sphere are distorted out of all their primitive simplicity. The whole irregular distribution of rainfall and aridity,

of permanent, seasonal, and variable winds, of sea climate and land climate, is the resultant of the guiding action of land-forms on the air and water currents, disturbed in this way from their primitive theoretical circulation. So far we see the surface-forms of the Earth, themselves largely the result of the action of climatic forces, and constantly undergoing change in a definite direction, controlling the two great systems of fluid circulation. These in turn control the distribution of plants and animals, in conjunction with the direct action of surface relief, the natural regions and climate belts dictating the distribution of living creatures. A more complicated state of things is found when the combined physical and biological environment is studied in its incidence on the distribution of the human race, the areas of human settlement, and the lines of human communication. The complication arises partly from the fact that each of the successive earlier environments acts both independently and collectively; but the difficulty is in greater degree due to the circumstance that man alone among animals is capable of reacting on his environment and deliberately modifying the conditions which control him.

I have said before, and I repeat now, that the glory of geography as a science, the fascination of geography as a study, and the value of geography in practical affairs arise from the recognition of this unifying influence of surface relief in controlling, though in the higher developments rather by suggestion than dictation, the incidence of every mobile distribution on the Earth's surface. I am inclined, in the light of these views, to put forward a definition of geography which I think may be accepted in principle, if not in phrase, by most of the class called by Prof. Davis "mature geographers" on both sides of the Atlantic. It runs:

Geography is the science which deals with the forms of relief of the Earth's crust and with the influence which these forms exercise on the distribution of all other phenomena.

The old pigeon-hole view of human knowledge is now happily discredited and recognized as useless, save, perhaps, by some Rip van Winkles of science, who concern themselves more with names than things, and would cheerfully misconceive the facts of nature to fit the framework of their accepted theories. High specialism is necessary to progress, but only as a phase of a working life, not as the whole purpose of a whole man.

It is convenient and often profitable for a man of science to have a recognized label, but it seems to me that important advances are to be made by cultivating those corners of the field of knowledge

which lie between the patches where the labelled specialists toil in recognized and respected supremacy. It has been so habitual to classify the man of science by what he works in that it requires something of an effort to see that the way in which he works is of greater determinative importance. Thus the scientific geographer is apt to find no place in the stereotyped classification, and his work may be lost sight of on that account. Should he dwell on latitude and longitude, the astronomer smiles pityingly; if he looks at rocks, the geologist claims that department; if he turns to plants, the botanist, with the ecologist behind him, is ready to warn him off; and so with other specialists. But the mature geographer seeks none of the territory, and hankers after none of the gold-fields belonging to recognized investigators. He works with the material they have already elaborated, and carries the process a step farther, like the goldsmith handling the finished products of the metallurgist and the miner.

The present problems of geography seem to me to be of two kinds—the first minor and preliminary, the completion of the unsolved and partially-solved problems of the past; the second ultimate and essential, dealing with the great problem on the solution of which the whole future of the science rests.

The residual problems inherited from the past represent the work which should have been done by our predecessors, but, not having been done at the right time, remains now to bar our progress. It has to do only with ascertaining and accurately recording facts, and involves infinite labour but comparatively little geographical thought.

To begin with, the ground should be cleared by wiping off the globe the words *terra incognita*. Such unknown parts of the Earth now cling about the poles alone, and that they should even do this is a disgrace to us. If common terrestrial globes were pivoted on equatorial points, so that the polar areas were not covered with brass mountings, I think the sight of the bare patches would have been so galling to the pride of humanity that they would long since have been filled in in detail. Again and again, and never more splendidly than in recent years, polar explorers have shown courage and perseverance, and have cheerfully encountered hardships enough to have enabled them to reach the poles; and they would have done so, not once but many times, were it not for the want of money. Of course, all polar explorers have not been competent for the task they undertook; but most of the leaders, if they had had more powerful ships, more coal, more stores, more dogs—and

sometimes if they had had fewer men—could have solved these perennial problems of exploration. With a competent man in command—and competent men abound—a sufficiency of money is all that is required. A million dollars judiciously spent would open the way to the north pole, a few millions would reach the south pole; but far more than this has been spent in vain because the money was doled out in small sums at long intervals, sometimes to explorers with no real call to the quest and working in accordance with no scientific plan.

The grand polar journeys of Nansen, Peary, and Cagni in the north, and of Scott and his company in the south, promise well for an early solution of this particular problem.

The other residual problems of exploration and survey are in the same case. If those who control money saw it to be their duty to solve them, they would all be solved, not in a year, but in due time. Though a great deal of exploration remains to do, the day of the ignorant explorer is done. The person who penetrates a little-known country in search of adventures or sport, or in order to go where no one of his colour or creed has been before, is, from the geographical point of view, a useless wanderer; and if he be a harmless wanderer, the true explorer who may follow in his footsteps is uncommonly fortunate. Exploration now requires, not the pioneer, but the surveyor and the student.

The map of the world ought to be completed, and it is the duty and, I believe, the interest of every country to complete that portion which includes its own territory. An imperial policy which ignores such an imperial responsibility is a thing of words and not of deeds. Unsurveyed and unmapped territory is a danger, as well as a disgrace, to the country possessing it; and it would hardly be too much to say that boundary disputes would be unknown if new lands were mapped before their mineral wealth is discovered. The degree of detail required in any survey depends upon the importance of the region. The desideratum is not a large-scale map of every uninhabited island, but a map of the whole Earth's surface on the same scale, which for the present may be a small one, and might very well be that of 1:1,000,000 proposed by Prof. Penck, and now being carried into effect for many of the surveyed portions of the land. Such a map ought to include sub-aqueous as well as sub-aërial features, and when completed it would form a solid basis for the full discussion of many problems which at present can only be touched upon in a detached and unsatisfactory manner. The first problem which it would solve is the measurement of the volume of

the oceanic waters and of the emergent land, so that the mean depth of the oceans and the mean heights of the continents may be exactly determined. This would involve, besides the horizontal surveys, a vertical survey of considerable accuracy. At sea the vertical element is easily found, and the depths measured by surveying and exploring vessels in recent years are very accurate. They must, however, be made much more numerous. On land, outside the trigonometrically-surveyed and spirit-levelled countries, the vertical features are still most unsatisfactorily delineated. Barometric determinations, even when made with mercurial barometers or boiling-point thermometers, are uncertain at the best, while when made with aneroids they afford only the roughest approximations to the truth. Where levelling is impracticable, angular measurements of prominent heights, at least, should be insisted on as an absolute necessity in every survey.

When a map of the whole surface of the Earth on the scale of 1:1,000,000 is completed, we may consider the residual problems as solved. This is far from being the case as yet, and in the present circumstances the most useful work that the geographical societies of the world could do would be to secure the completion of explorational surveys to that scale. The system of instruction for travellers established by the Royal Geographical Society has equipped a large number of explorers and colonial officials as expert surveyors, and the result is now being felt in every quarter of the globe. This is not the highest geographical work, but merely preliminary and preparatory; yet progress is checked, if not barred, until it is accomplished. The map of one to a million is not to be viewed as an end in itself; nevertheless its completion will mark an era—the accomplishment of the small-scale survey of the globe.

Money could solve the last of the problems of exploration, but when we come to problems of the second category we enter a region of pure science, where money becomes a minor consideration. The acquisition of knowledge is a simple process, for which multitudes have a natural aptitude; but the co-ordination of knowledge and its advancement are very different matters. The difference is more marked in the case of geography than in geology or chemistry or physics; for, in English-speaking countries at least, the training of geographers is in its infancy, whilst that of the exponents of other sciences is highly developed. Hence it happens that before any actual problem in geography can be attacked, the man who is to deal with it must be prepared on purpose for the task, and he must have determination enough to stick to an unpopular subject with

little encouragement in the present and small prospects for the future. Such men are not too easily found.

If they can be found, the problems to which they should be set are at hand and waiting. We know enough about the relations of mobile distributions to fixed environments to feel satisfied that the relations are real and of importance; but we do not yet know enough to determine exactly what the relations are and the degree in which they apply to particular cases. It is the aim of geography to find this out, and to reduce to a quantitative form the rather vague qualitative suggestions that have been put forward. The problem is multiform and manifold, applying to a vast range of phenomena, and those who have surveyed it are often inclined to sigh for a Kepler or a Newton to arise and call order from the chaos.

A vast amount of material lies before the geographer with which to work, even though, as has been explained, much more is needed before the data can be looked upon as complete. After seeing that the missing facts are in course of being supplied, the great thing is to work and to direct the work of others towards the proper comprehension of the facts and their bearings. This involves as much the checking and discouragement of work in wrong or useless directions as the help and encouragement of well-directed efforts.

The first element of geography is the configuration of the crust of the Earth, and our knowledge is already ripe for a systematic classification of these forms and for a definite terminology by which to describe them. For some reason not easy to discover geographical terms, with the exception of those handed down from antiquity, have not, as a rule, been taken from the Greek, like other scientific terms. They have usually been formulated in the language of the author who has introduced them. For this reason they retain a national colour, and, absurd as it may seem to scientific reflection, national or linguistic feeling is sometimes a bar to their general adoption. A more serious difficulty is that different languages favour different modes of thought, and thus lead to different methods of classification. The clearness and definiteness of French conduce to the use of simple names and the recognition of definite features, distinguished by clear differences. The facility for constructing compound words presented by German lends itself to the recognition of composite types and transition forms, the introduction of which often swells a classification to an almost unmanageable complexity. English stands intermediate

between those languages, less precise, perhaps, than French, certainly less adaptable than German, and English terminologies often reflect this character. The best way out of the difficulty seems to be to endeavour to arrive at a general understanding as to a few broad types of land-form which are recognized by every one as separate and fundamental and then to settle equivalent terms in each important language by an international committee, the finding of which would have to be ratified by the national geographical societies. These terms need not necessarily be identical, nor even translated literally from one language into another, but their equivalence as descriptive of the same form should be recognized. A recent international committee appointed for the nomenclature of the forms of sub-oceanic relief put forward certain suggestions in this direction which might well be adapted to the forms of sub-aërial relief as well. But there are strong-willed geographers who will recognize no authority as binding, who will not, I fear, conform to any scheme which might threaten their liberty to call things as they please.

Personally, I would go very far to obtain uniformity and agreement on essential points, but the only way to do so seems to be to arrive by general agreement at a classification that is as brief, simple, and essential as possible.

It is necessary to classify land-forms according to their resemblances and differences, so that similar forms may be readily described, however far apart they may be. The fixed forms of the crust are the foundation of all geography, the ultimate condition underlying every distribution, the guiding or controlling resistance in every strictly geographical change. The question of place-names is altogether subordinate. It is convenient that every place should have a name, and desirable that the name should be philologically good, but the national boards of geographic names, geographical societies, and survey departments see to that, and do their work well. The question of terminology is far more difficult, and, I think, more pressing.

The grand problem of geography I take to be the demonstration and quantitative proof of the control exercised by the form of the Earth's crust upon the distribution of everything upon the surface or in contact with it which is free to move or to be moved. It is a great problem, the full solution of which must be long delayed, but every part of it is a bud with minor problems of detail, alike in nature but differing widely in degree. These minor problems claim our attention first, and are so numerous that one fears to

attempt their enumeration because of the risk of distracting attention from the main issue. Geography was defined long ago as the science of distribution; but the old idea was statical distribution, the laying down on maps of where things are; now we must go farther, and discuss also how the things came there, why they remain there, whether they are in transit, and, if so, how their path is determined. We now look on distribution from its dynamical side, the Earth with all its activities being viewed as a machine at work.

The geographer, as an independent investigator, has to deal only with matters touching or affected by the crust of the Earth; his subject is limited to a part only of the economy of the Kosmos.

The quantitative relationships of crustal control have to be worked out for different areas with different degrees of detail. A great deal has been done already, and the material for much more has been collected in a form fit for use. The first step in commencing such a discussion is the accurate mapping of all available data—each kind by itself—for the particular area. On the national and almost continental scale this is done better in the United States Census Reports than in any other works known to me. An adequate discussion of all that is shown in the maps accompanying these Reports, and in those of the Coast and Geodetic Survey, the Geological Survey, and the Department of Agriculture, would be a complete and almost an ideal geographical description. The material provided in such rich profusion by the Federal and State Governments is being used in Harvard and elsewhere with an originality and thoroughness that have developed the conception of geography and advanced its scientific position. American geographers more than others have grasped the dynamic idea of geography, and realized that the central problem is the elucidation of the control or guidance exercised by fixed forms on mobile distributions.

Detailed work in the same direction has been done by many European geographers, whose works are too well known to require citation; but the geographical treatment of statistics has not been taken up adequately by public departments in the countries east of the Atlantic. To touch only on the instance most familiar to me, with the exception of the maps of the Admiralty, Ordnance and Geological Surveys, which cannot be surpassed, the maps issued by British Government Departments in illustration of their reports are rarely more than diagrams delimiting the areas dealt with, but not depicting the distributions. This is the more regrettable because the accuracy and completeness of the statistics in the reports are

inferior to none and superior to most work of a similar character in other countries. As frequently happens, private enterprise has stepped in where official action is wanting, and it is a pleasure to the geographer to turn to the recent work of Mr. J. G. Bartholomew, especially the volume of his great Physical Atlas, the Atlas of Scotland published some years ago, and the Atlas of England and Wales which has just left the press. Both of the latter works contain general maps based on statistics that have not been subjected to cartographic treatment before, and attention may be drawn in particular to the singularly effective and suggestive mapping of density of population. Another work similar in scope and no less creditable to its compilers is the Atlas of Finland, prepared by the active and enlightened Geographical Society of Helsingfors. In Germany, France, and Russia, also, examples may be found of good work of this kind, sufficient to whet the desire for the complete and systematic treatment of each country on the same lines.

It seems to me that the most useful application of youthful enthusiasm in geography, such as breaks forth in the doctoral theses of German universities, and is solicited in the programme of the Research Department of the Royal Geographical Society, would be towards the detailed comparison of the distribution of the various conditions dealt with statistically in Government Reports with the topographical map of selected areas. The work would, of course, not stop with the maps; for these, when completed, should be tested and revised as fully as possible on the ground, since geography, be the scale large or small, is not advanced by maps alone.

Such small portions of the co-ordination of existing surveys are at the best no more than fragments of a complete scheme, but they show what can be done with existing surveys and actual statistics, and where these may be appropriately reinforced by new work. I have treated a special case of this kind pretty fully in papers, to which it is only necessary to refer.* One section of the scheme outlined and exemplified in these papers is the distribution of rainfall viewed in relation to the configuration of the land; and with the active assistance of nearly four thousand observers in the British Isles, I feel that there is some prospect, though it may lie far in the future, of ultimate results from that study.

The system of botanical surveys now being carried on with signal success in many countries is in some ways even more inter-

* *Geographical Journal*, 7 (1896), 345-364; 15 (1900), 205-226, 353-377.

esting. It includes the mapping of plant associations and the discussion of their relation to altitude, configuration, soil, and climate. Such phenomena are comparatively simple, and the influence of the various modifications of geographical control is capable of being discovered. I need only mention the similar problems in animal distribution, both on land and in the sea, to the elucidation of which many able workers are devoting themselves.

Difficulties increase when the more complicated conditions of human activity are taken into account. The study of the geographical causes determining, or assisting to determine, the sites of towns, the lines of roads and railways, the boundaries of countries, the seats of industries and the course of trade is full of fascination and promise. It has yielded interesting results in many hands; above all, in the hands of the leading exponent of anthropogeography, the late Prof. Ratzel, of Leipzig, whose sudden death last month is a grievous loss to geographical science.* Had he lived he might have carried the lines of thought which he developed so far to their logical conclusion in the formulation of general laws of universal application; but that task devolves on his disciples. Separate efforts in small and isolated areas are valuable, but a much wider basis is necessary before general principles that are more than hypotheses can be deduced. For this purpose there must be organized co-operation, international if possible, but, in the present condition of things, more probably on a national footing for each country. To be effective the work would have to be on a larger scale and to be continued for a longer time than is likely to appeal to an individual or a voluntary association. One experienced geographer could direct an army of workers, whose task would be to collect materials on a properly thought-out plan, and from these materials the director of the work could, before long, begin to produce results which will not probably be sensational, but will be accurate and thorough—which is far better. The director of such a piece of work must be free to disregard the views of the collectors of the facts with which he deals if, as may very well happen, these views are at variance with scientific principles.

A complete geographical description should commence with a full account of the configuration of the selected area, and in this I lay less stress than some geographers feel it necessary to do upon the history of the origin of surface-features. The features themselves control mobile distributions by their form, irrespective of the

* Prof. Ratzel died August 9, 1904.

way in which that form was produced; and although considerations of origin are often useful and always interesting, they are apt to become too exclusively geological. The second point to discuss is the nature of the actual surface, noting the distribution of such geological formations as volcanic rocks, clays, limestones, sandstones, and economic minerals, the consistency and composition of the rocks being the points to which attention is directed, the geological age an entirely subordinate matter. To this must be added a description of the climate as due to latitude, and modified by altitude, exposure, and configuration, then the distribution of wild and cultivated plants in relation to their physical environment, and of the industries depending on them, and on other natural resources. As the conditions increase in complexity, historical considerations may have to be called in to aid those of the actual facts of to-day. The lines of roads and railways, for example, are usually in agreement with the configuration of the localities they serve; but anomalies sometimes occur the explanation of which can only be found by referring to the past. The more transitory features of a country may have acted differently at different times in affording facilities or interposing barriers to communication. The existence of forests long since destroyed, of marshes long since drained, of mineral deposits long since worked out, or of famous shrines long since discredited and forgotten, account for many apparent exceptions to the rules of geographical control. In long-settled countries the mobile distributions do not always respond immediately to a change of environment. A town may cease to grow when the causes that called it into existence cease to operate, but it may remain as a monument of former importance and not wither away. As one ascends in the geographical system, the mobility of the distributions which have to be dealt with increases, and the control of crust-forms upon them diminishes, and non-geographical influences play an increasing part. It may even be that causes altogether outside of geographical control account for the persistence of worn-out towns, the choice of sites for new settlements, or the fate of existing industries. If this be really so, I think it happens rarely, and is temporary. Geographical domination, supreme in simple conditions of life, may be modified into geographical suggestion, but in all stable groupings or continuous movements of mankind the control of the land on the people will surely assert itself. How? and To what degree? are the questions to which the modern geographer must seek an answer.

A special danger always menaces the few exponents of modes of study which are not yet accepted as of equal worth with those of the conventional sciences. It is the nemesis of the temptation to adopt a plausible and probably true hypothesis for the demonstrated truth, and to proclaim broad and attractive generalizations on the strength of individual cases. Geographers have perhaps fallen into the error of claiming more than they can absolutely prove in the effort to assert their proper position; but the fault lies mainly at other doors. In geography it is not always easy to obtain exact demonstrations, or to apply the test of accordance with fact to an attractive hypothesis; and it is necessary to be on guard against the publication of attractive speculations as if they were established truths. The methods of journalism—even of the best journalism—are to be absolutely discouraged in science. The new is not necessarily truer or better than the old simply because it is new, and we must remember that time alone tests theories. It is a danger to become too popular. The scientific study of geography should be carried on with as many safeguards of routine verification and patient repetition—and, it may be, within as high a fence of technical terminology—as, say, physiology, before the results can be obtained. Unfortunately the idea is prevalent that geography is an easy subject, capable of being expounded and exhausted in a few popular lectures. I regret to see the growing tendency amongst teachers of geography to deprecate the acquisition of facts, to shorten and “simplify” all chains of reasoning, to generalize over the heads of clamant exceptions, and even to use figures, not as the ultimate expression of exact knowledge but merely as illustrations of relative magnitude. I quite allow that all this may be legitimate and laudable in the early stages of elementary education; but it should never pass beyond this, and every vestige of such a system of evading difficulties should be purged from the mind of the aspirant to research.

The facts available are neither so well known nor so easily accessible as they should be. Much has been done towards the indexing of the current literature of all sciences, and geography is peculiarly fortunate in possessing the exhaustive annual volumes of the *Bibliotheca Geographica*, published by the Berlin Geographical Society, the carefully-selected annual bibliography of the *Annales de Géographie*, the critical and systematic chronicles of the *Geographisches Jahrbuch*, and the punctual monthly lists of the *Geographical Journal* and *Petermanns Mitteilungen*, not to speak of the work of the “International Catalogue of Scientific Literature.” A

great desideratum is an increase in the number of critical bibliographies of special subjects and particular regions, prepared so carefully as to relieve the student from the necessity of looking up any paper without being sure that it is the one he requires to consult, and to save him from the weary labour of groping through many volumes for fragmentary clues. In addition to the sources of information usually catalogued in one or other of the publications cited, there exist in every country numbers of Government reports and quantities of periodical statistics too valuable to deserve their usual fate of being compiled, printed, and stored away and forgotten. There is scope for a great deal of hard but very useful and permanently valuable work in throwing all these open to working geographers by providing analytical indexes. This would make it easier to discuss current Government statistics with the highest degree of precision, and to compare past with present distributions. All such statistics should be subject to a cartographical treatment no less rigidly accurate than the ordinary arithmetical processes.

The ultimate problem of geography may, perhaps, be taken as the determination of the influence of the surface-forms of the Earth on the mental processes of its inhabitants. But a host of minor problems must be solved in cutting the steps by which that culmination is reached. Let us first find the exact relationship between the elevation, slope, and exposure of land on climate; then the true relation between elevation, slope, soil, exposure, and climate on vegetation; then the actual relation between all these and agriculture, mining, manufacture, trade, transport, the sites of towns, the political associations of peoples, and the prosperity of nations. After that we may consider whether it is possible to reduce to a definite expression the relation between the poetry or the religion of a people and their physical surroundings. The chemist Chenevix wrote a book in two volumes a hundred years ago to demonstrate the inferiority of a certain nation, against one of whose citizens he bore a personal grudge, and he was bold enough to attempt to justify the formula $C=f\lambda$, where C represented civilization, λ the latitude, and f a function so delicately adjusted as to make the value of C negative on one side of a channel twenty miles wide and positive on the other. We cannot hope to arrive by any scientific process at so definite a formula, but the only way of getting there at all is by forging the links in as unbroken a chain of cause and effect as that which led from the "house that Jack built" to "the priest all shaven and shorn."

The last of the problems of geography on which I intend to touch is that of the training of geographers. So far as elementary instruction in geography is concerned I have nothing to say, except that it was bad, it is better, and it seems likely that it will be very good. But between geography as part of the education of a child and geography as the whole life-work of a man there is a gulf as wide as between nursery rhymes and the plays of Shakespeare. The training of an elementary teacher in geography should be more thorough and more advanced than that of a child, but it need not be of a different order. The teacher, whose special function is teaching, must, like the child, accept the facts of geography from the authorities who are responsible for them. Although the two gifts are sometimes happily combined, an excellent teacher may make but a poor investigator.

A would-be geographer has at present adequate scope for training in very few universities outside Germany and Austria. Great advances have been made in the United States, but it is only here and there amongst the universities that steps have been taken to secure men of the first rank as professors who are not only channels of instruction but masters of research as well. In the United Kingdom there are lecturers on geography at several universities and many colleges; and, although they have done good work, the system adopted fails, in my opinion, on a practical point—the lecturers are so inadequately paid that they cannot afford to give their whole time or their undivided attention to the subject with which they are charged. In such conditions progress cannot be rapid, and research is almost impossible. The absence of any well-paid posts, by attaining which a geographer would be placed in a position equivalent to that of a successful chemist or mathematician or botanist, kills ambition. The man with his income to make cannot afford to give himself wholly to such a study, however great his predilection for it. The man with as much money as he wants rarely chooses “to scorn delights and live laborious days,” and—with some bright exceptions—he has a tendency, when he turns to science at all, to study it rather for his own satisfaction than for the advance of the subject or the help of his fellows. We want some adequate inducement for solid scientific workers, well trained in general culture, and fitted to come to the front in any path they may select; to devote their whole attention—and the whole attention of such men is a tremendous engine—to the problems of geography. The labourer is worthy of his hire, and the services of the most capable men cannot reasonably be expected if

remuneration equivalent to that offered to men of equal competence in other subjects is not available. At some American and several German universities such men can receive instruction from professors who are masters of the science, free to undertake research themselves and to initiate their students into the methods of research—the best training of all.

If the time should come when there are, perhaps, a dozen highly-paid professorships in English-speaking countries, several dozen aspirants will be found, including, we may hope, a few more gifted than their masters, all qualifying for the positions, stimulated by rivalry, and full of the promise of progress. This is not an end, but the means to an end. Rapid progress is impossible without the stimulus of the intercourse of keenly-interested and equally-instructed minds. Geography, like other sciences, has to fight its way through battles of controversy, and smooth its path by wise compromises and judicious concessions, before its essential theory is established and universally accepted. We can already see, though somewhat dimly, the great principles on which it depends, and they are becoming clearer year by year. As they are being recognized they may be applied in a provisional way to current problems of practical life. The world is not yet so fully dominated by the highest civilization, nor so completely settled, as to deprive geographers of an opportunity of showing how the settlement and development of new lands can best be carried out in the light of the permanent relationships between land and people discovered by the study of the state of matters of long-settled areas at the present day and in the past.

The practical politician, unfortunately, thinks little of geographical principles, and hitherto he has usually neglected them utterly. Many burning questions that have disturbed the good relations and retarded the progress of nations, even when they did not burst into the conflagration of war, would never have got alight had the consequences of some apparently trifling neglect, or some careless action, been understood beforehand as clearly by the man of affairs as by the student of geographical principles. Perhaps when geography has obtained the status in the world of learning to which its ideals and achievements entitle it the geographer may be permitted, when the occasion demands, to assist in saving his country from extravagance or disaster.